Harvard Electricity Policy Group Ninety-Seventh Plenary Session

Offshore Wind: Barriers and challenges to Meaningful Market Entry

Marana, AZ
December 13, 2019

Kevin Knobloch, President
New York OceanGrid LLC
Anbaric Development Partners

ANBARIC®

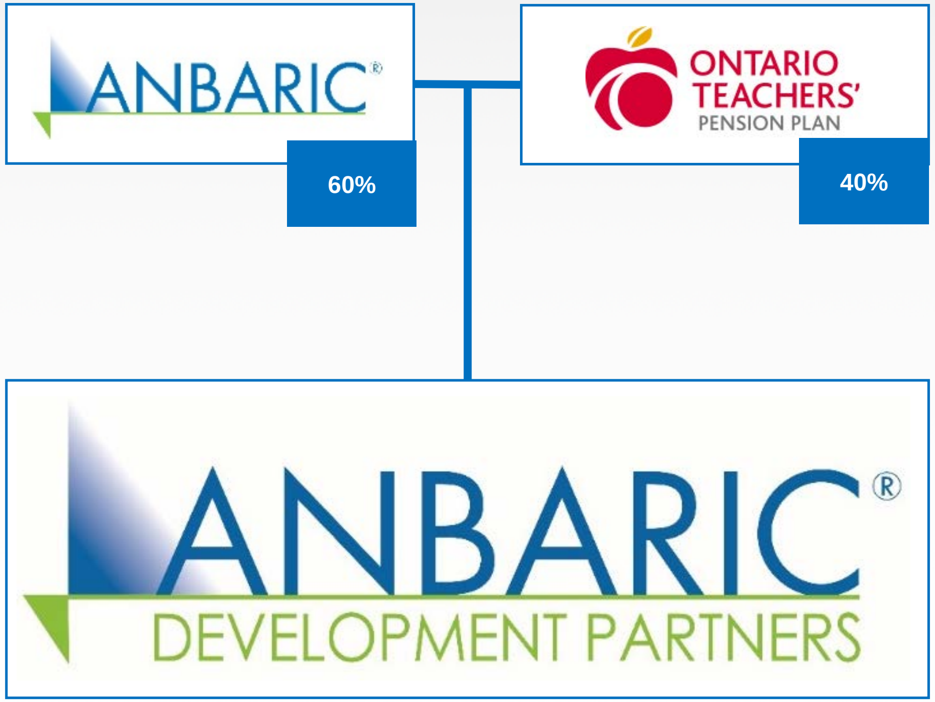
Anbaric and Ontario Teachers Pension Plan partnership

Anbaric Development Partners (ADP) develops renewable energy transmission and battery storage projects in North America.

Anbaric was founded in 2004 by Ed Krapels. ADP was formed in March 2017 as a partnership between Anbaric and Ontario Teachers' Pension Plan (OTPP).

OTPP has $201.4 billion (Canadian) in net assets and has earned an average annualized rate of return of 9.7% since the plan's founding in 1990.

Our partnership introduced a new model for pension fund investment in infrastructure and energy that enables Anbaric to deliver efficient, patient capital for long-term projects.

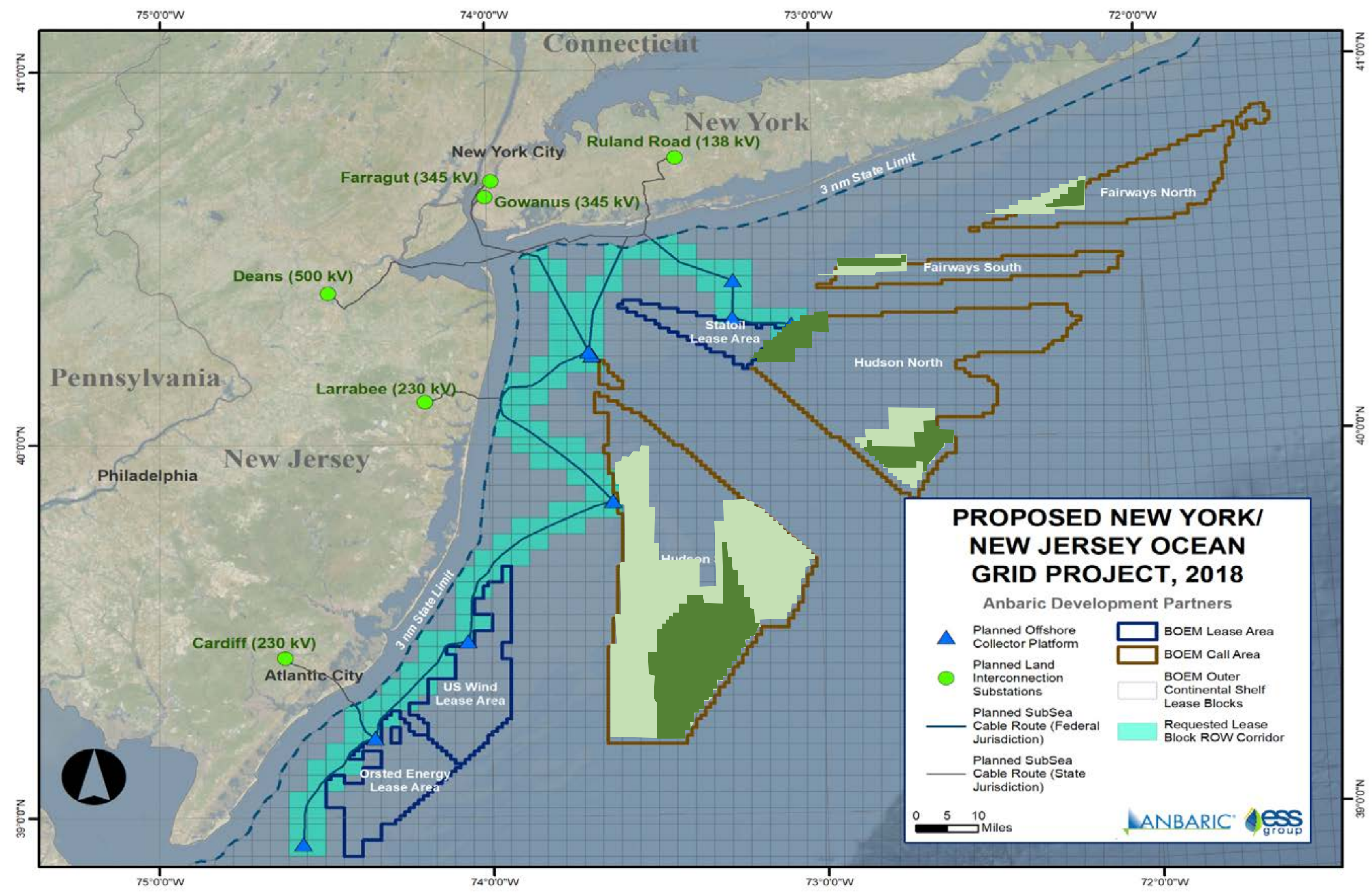


Proven track record co-developing transmission in NY and NJ

HUDSON

NEPTUNE
Regional Transmission System™

A proposed New York/New Jersey OceanGrid



- Subsea and underground cable installation efficiently connecting Wind Energy Areas to optimal onshore substations.
- Offshore collector stations minimize number of cable routes to shore.

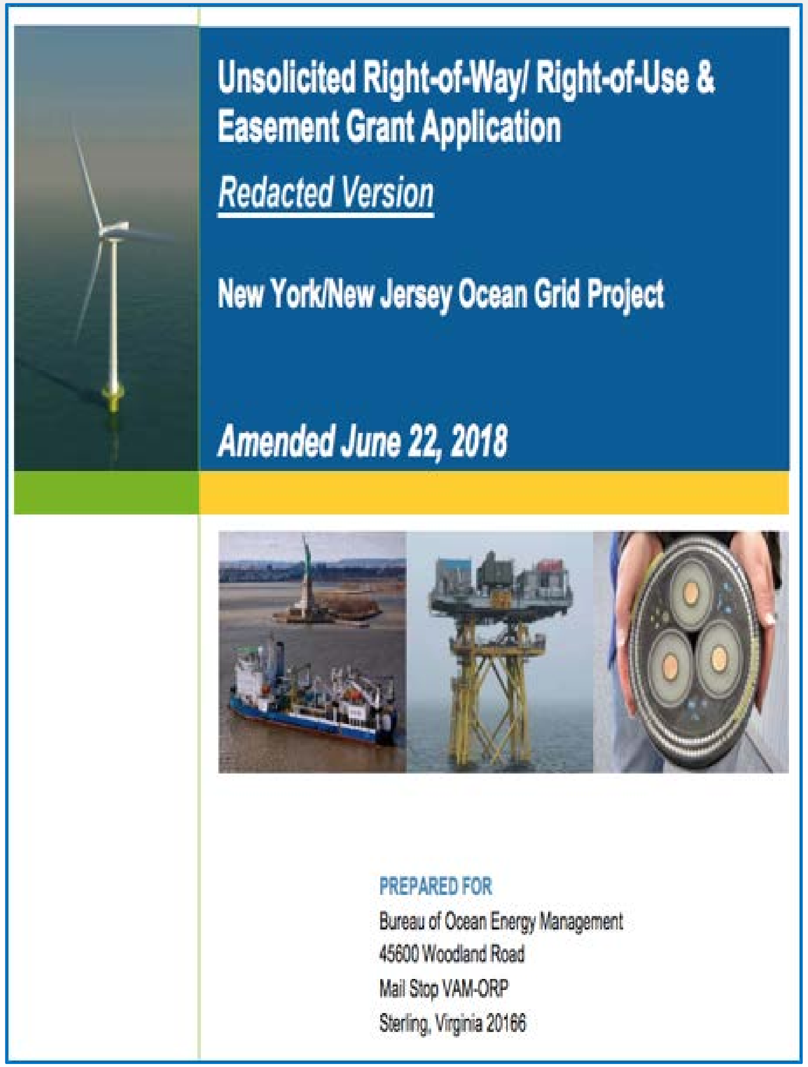
NY-NJ OceanGrid Right-of-Way and Right-of-Use Grant application to BOEM

BOEM
Bureau of Ocean Energy Management

April 2018: Anbaric files application with BOEM.

June 2018: BOEM approves ADP's legal, technical and financial qualifications to hold a ROW on the Outer Continental Shelf.

June 2019: BOEM issues a "Request for Competitive Interest".


Unsolicited Right-of-Way/ Right-of-Use & Easement Grant Application

Redacted Version

New York/New Jersey Ocean Grid Project

Amended June 22, 2018

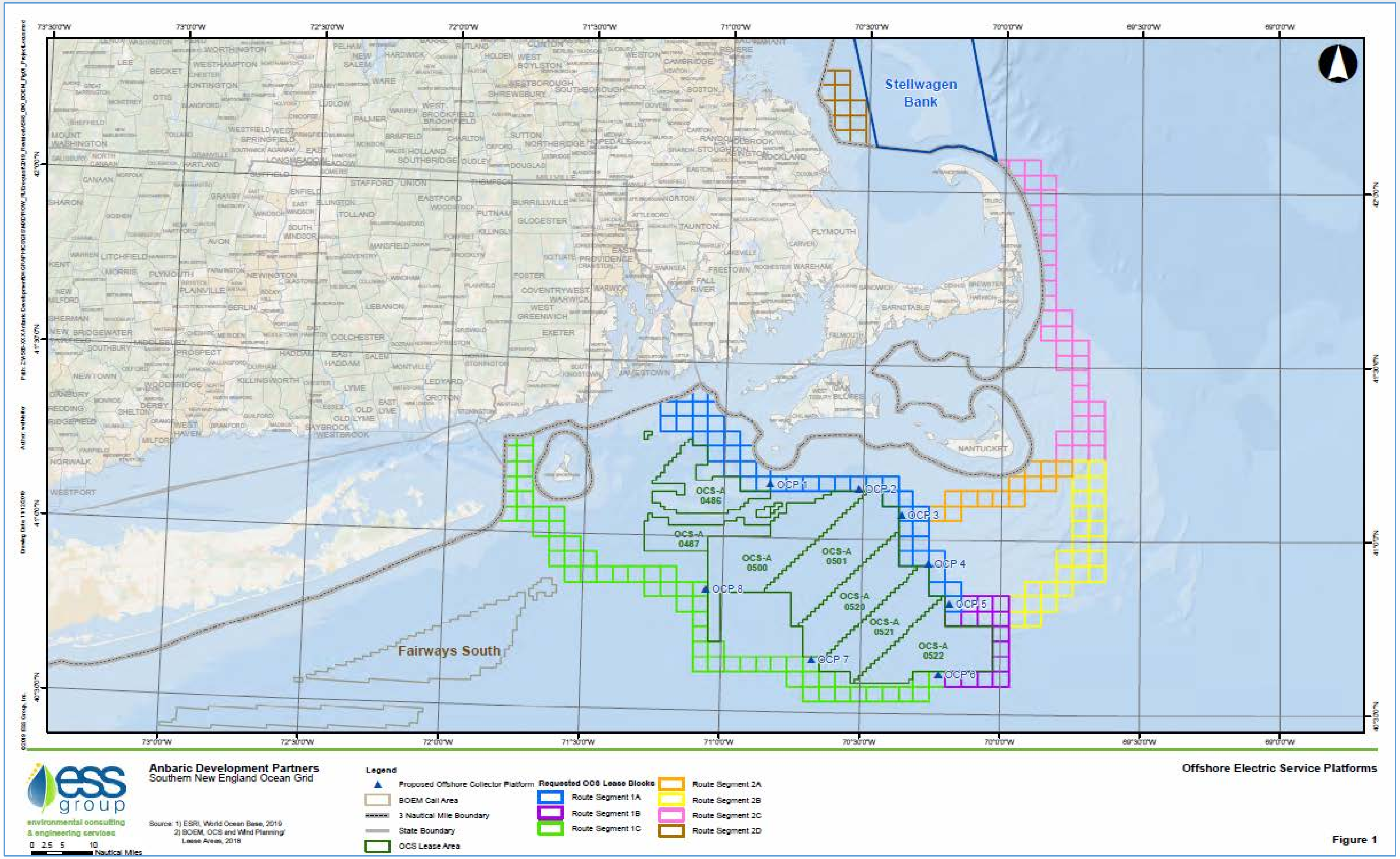
PREPARED FOR
Bureau of Ocean Energy Management
45600 Woodland Road
Mail Stop VAM-ORP
Sterling, Virginia 20166

Anbaric's Southern NE Ocean Grid ROW/ROU Application to BOEM

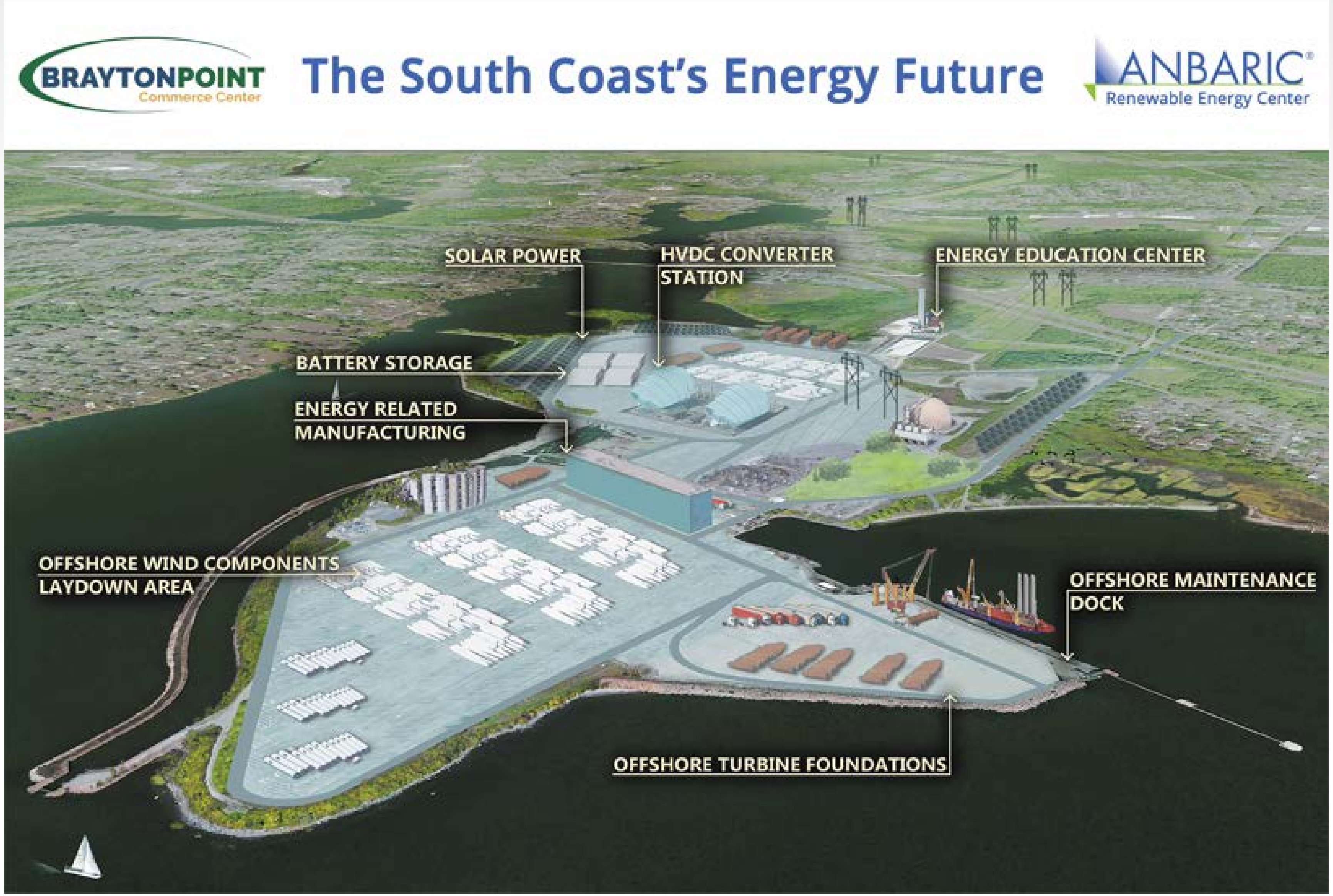
November 2019: ADP non-exclusive request filed with BOEM.

Request that BOEM publish application in Federal register no sooner than January 1, 2020.

Publishing triggers 30-day public comment period for competitive interest.



Anbaric's Brayton Point Renewable Energy Center



Liberty Wind: a partnership between Vineyard Wind and Anbaric

A rare opportunity to build a new domestic industry from scratch

The states along the Atlantic seaboard, working closely with the Federal government and private sector, have an extraordinary opportunity to build a new offshore wind industry, at scale, to provide clean energy to our factories, businesses and homes – along with new jobs, enormous investment opportunities and an expanded tax base.

The key to realizing this potential is planning the infrastructure -- an open-access offshore wind transmission network – to maximize public benefits.

Atlantic states setting pace with offshore wind goals, projects

State	OSW target	Awarded to date
Massachusetts	3,200	1600
Rhode Island	1,000	430
Connecticut	2,300	1100
New York	9,000	1,820
New Jersey	7,500	1,100
Maryland	1,200	368
Virginia	2,000	12
Total	**26,200 MW**	**6,430 MW**

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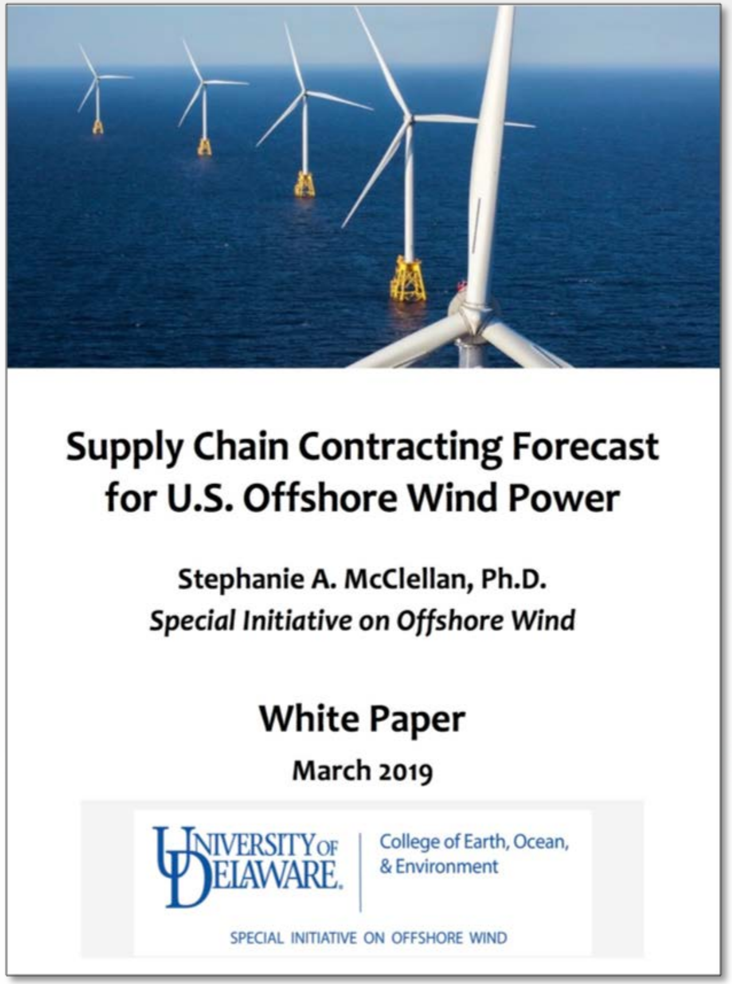
Offshore/onshore transmission buildout a large economic opportunity

Estimated Cumulative CAPEX by Component Type, 2030

Component	Cumulative CAPEX
Onshore substation EPCI	$2.1 bn
Upland cable EPCI	$0.7 bn
Offshore substation EPCI	$4.7 bn
Export cable	$5.5 bn
Array cable EPCI	$4.1 bn
Foundation EPCI	$16.2 bn
WTG EPCI	$29.6 bn
Other (marine support, insurance, PM)	$5.3 bn
Total	**$68.2 bn**


Supply Chain Contracting Forecast for U.S. Offshore Wind Power

Stephanie A. McClellan, Ph.D.
Special Initiative on Offshore Wind

White Paper
March 2019

UNIVERSITY OF DELAWARE | College of Earth, Ocean, & Environment
SPECIAL INITIATIVE ON OFFSHORE WIND

Source: Stephanie A. McClellan, Ph.D.
Special Initiative on Offshore Wind
University of Delaware

Tens of thousands of employment opportunities across a range of fields

Special Initiative on Offshore Wind: 40,000 new jobs by 2030.

New York-based *Workforce Development Institute* study: 74 occupations are needed to build OSW industry:

- Energy
- Construction (including electricians, plumbers, pipefitters, steamfitters, construction laborers, carpenters, construction managers, and general/operations managers)
- Finance
- Legal
- Technology
- Telecommunication
- Maritime industries
- Science
- Engineering

Gould, Ross and Cresswell, Eliot, "New York State and the Jobs of Offshore Wind Energy" (New York: Workforce Development Institute, 2017)

What public interest principles are we trying to achieve?

- Creative thinking
- Competition
- Job creation
- Affordability
- Reliability
- Redundancy
- Resilience
- GHG reduction

Reduce impacts on:

- Shoreline communities
- Commercial fishing
- Endangered marine species
- Environment

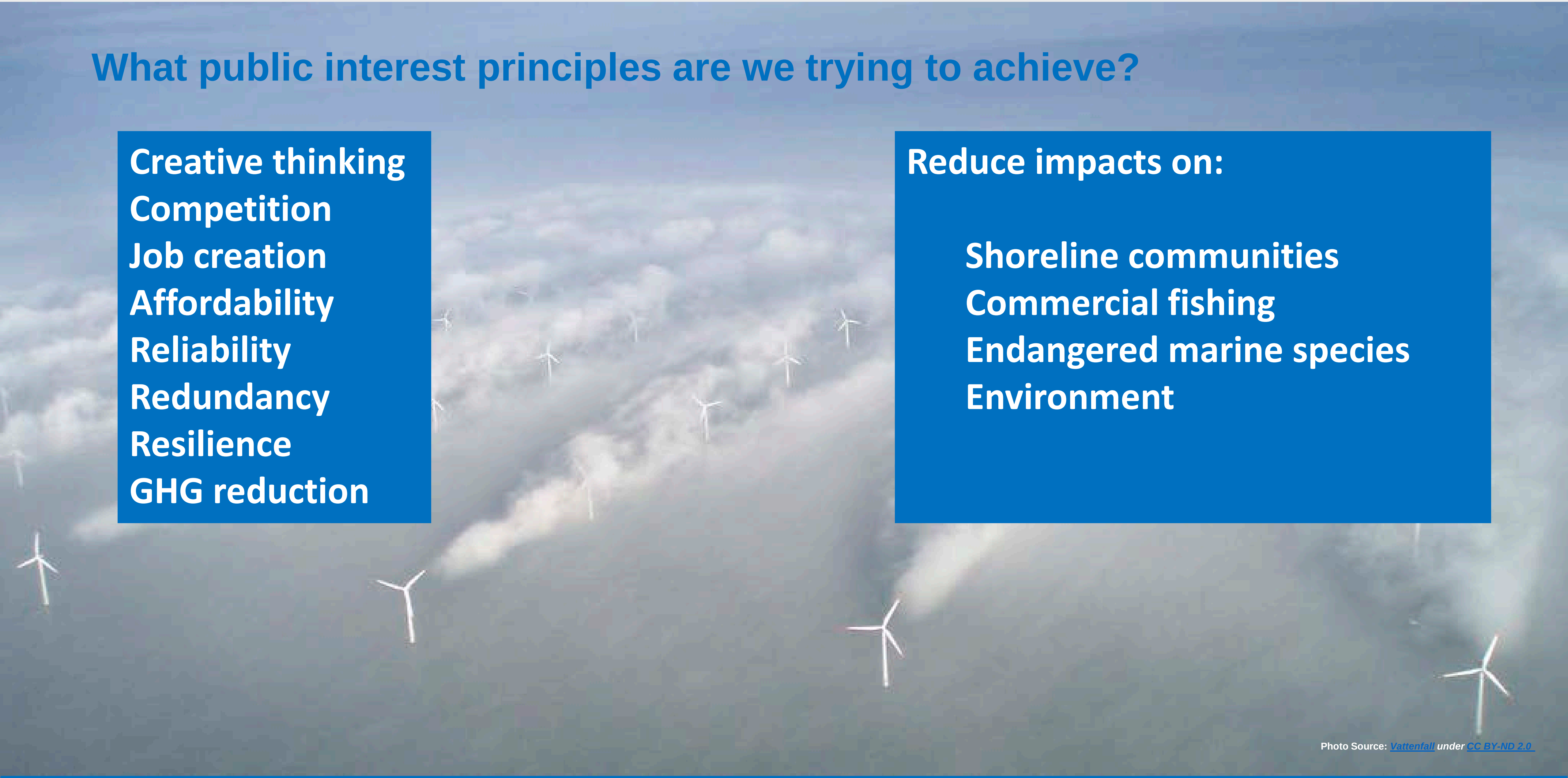


Photo Source: *Vattenfall* under *CC BY-ND 2.0*

New York State policies spurring deployment of renewable energy

1. **Greenhouse gas reductions:** Reduce statewide greenhouse gas emissions by 40 percent by 2030.

2. **Clean energy standard:** 100 percent clean energy by 2040 (and 70 percent clean energy by 2030).

3. **Offshore wind goal:** 9000 MW by 2035.

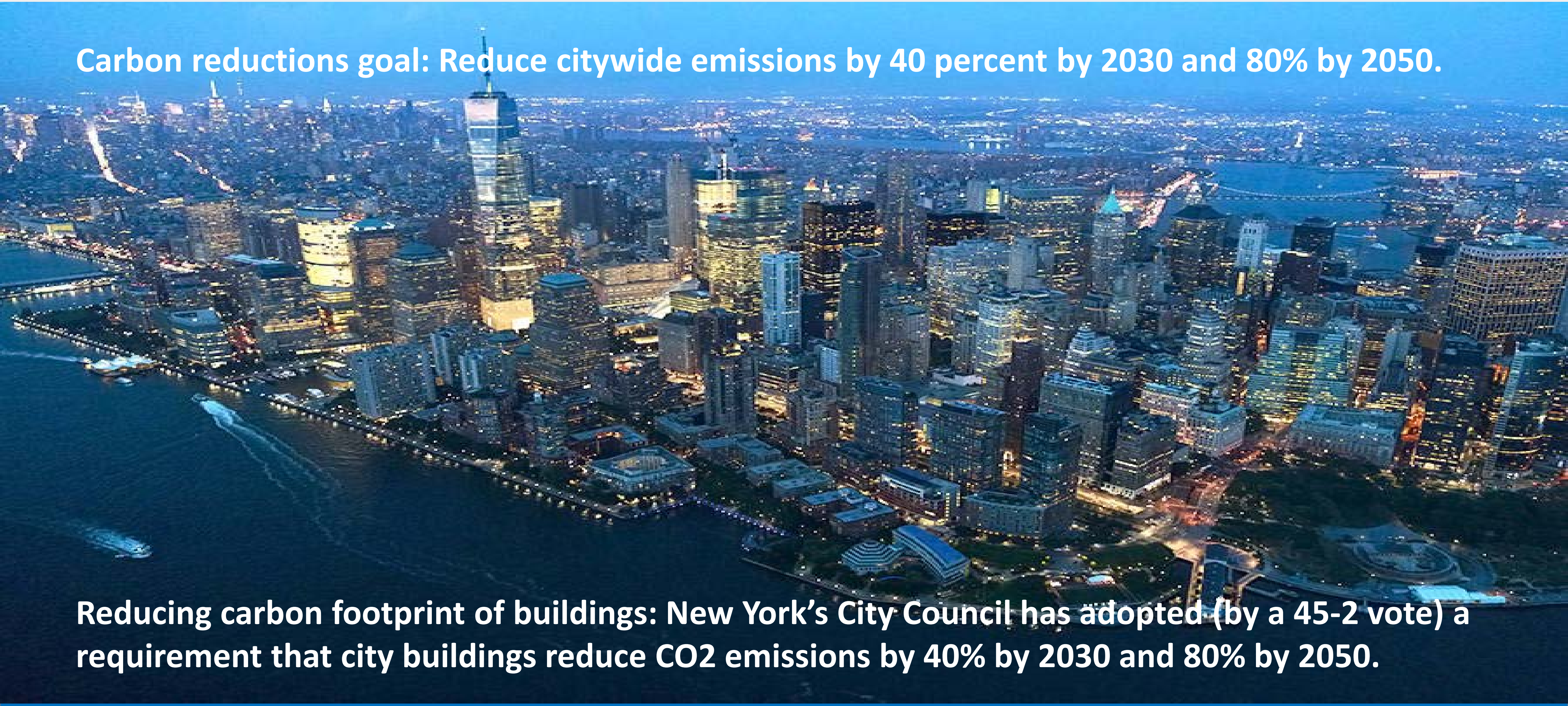
4. **Distributed solar goal:** 6000 MW by 2025.

5. **Battery storage mandate**: 3000 MW by 2030.

6. **Strengthened NOx standards for fossil peakers:** Designed to retire 3400 MW of older peaking units .

7. **Close all coal-fired power plants:** NYS Department of Environmental Conservation stringent limits of CO_2 emissions will end burning of coal by by 2020.

New York City policies spurring deployment of renewable energy



Carbon reductions goal: Reduce citywide emissions by 40 percent by 2030 and 80% by 2050.

Reducing carbon footprint of buildings: New York's City Council has adopted (by a 45-2 vote) a requirement that city buildings reduce CO_2 emissions by 40% by 2030 and 80% by 2050.

Transmission on land is separately owned and operated

Separation of generation and transmission on land has long been the rule, guided by FERC policy.

FERC Order 888 (1996):

- “(F)unctional unbundling of services [was] necessary to implement non-discriminatory open access transmission”
- “Non-discriminatory open access to transmission services is critical to the full development of competitive wholesale generation markets and the lower consumer prices achievable through such competition.”

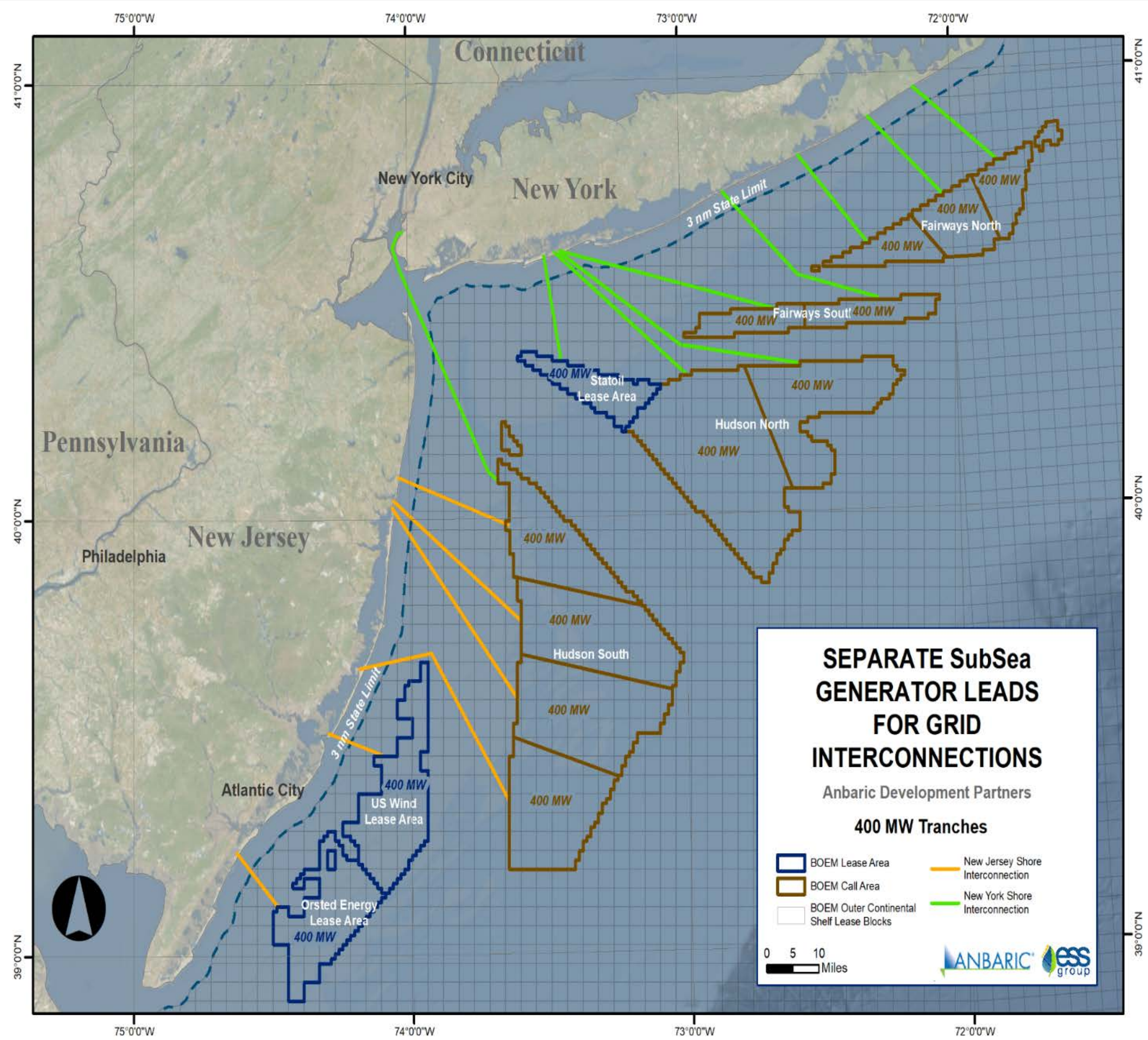
FERC worries about ”transmission monopolies”

FERC has explained that “[i]t is in the economic self-interest of transmission monopolists, particularly those with high-cost generation assets, to deny transmission or to offer transmission on a basis that is inferior to that which they provide themselves. **The inherent characteristics of monopolists make it inevitable that they will act in their own self-interest to the detriment of others by refusing transmission and/or providing inferior transmission to competitors in the bulk power markets to favor their own generation**.”

FERC concluded “that functional unbundling of services [was] necessary to implement non-discriminatory open access transmission” and that “[**n]on-discriminatory open access to transmission services is critical to the full development of competitive wholesale generation markets and the lower consumer prices** achievable through such competition.”

Source: FERC Order 888, 1996.

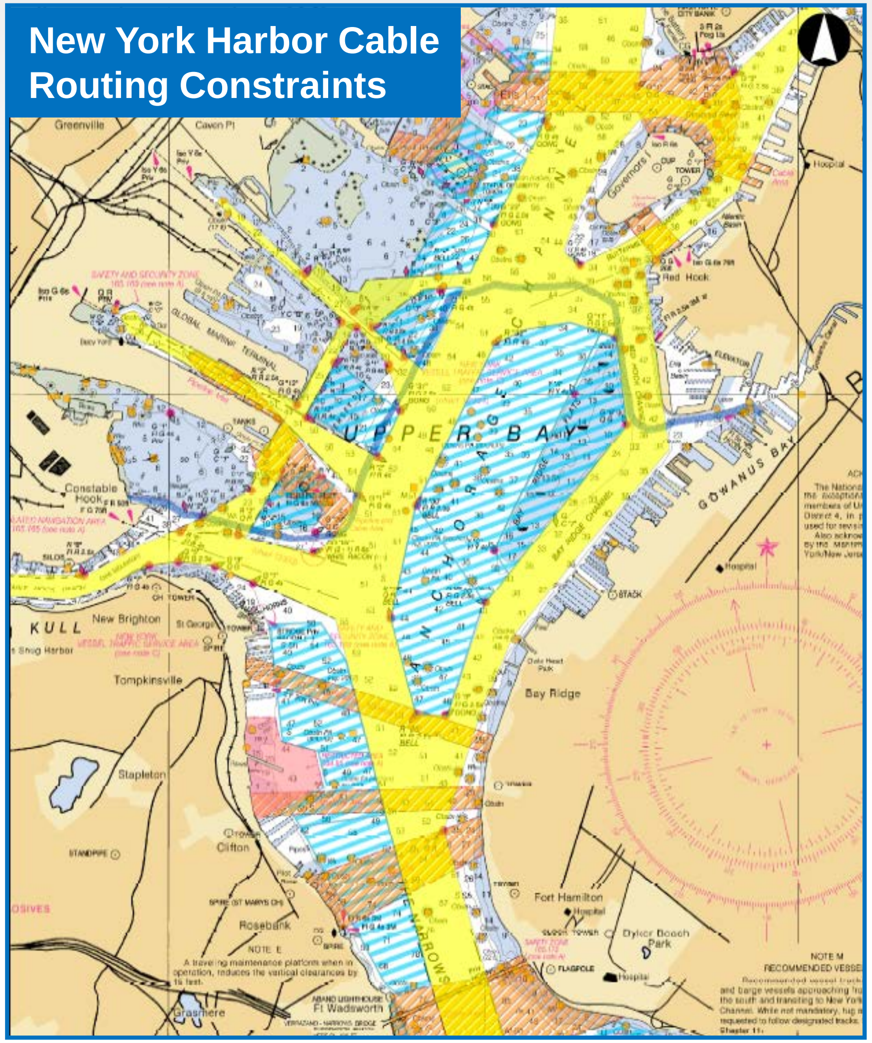
Gen lead lines: a short-term solution with longer-term problems

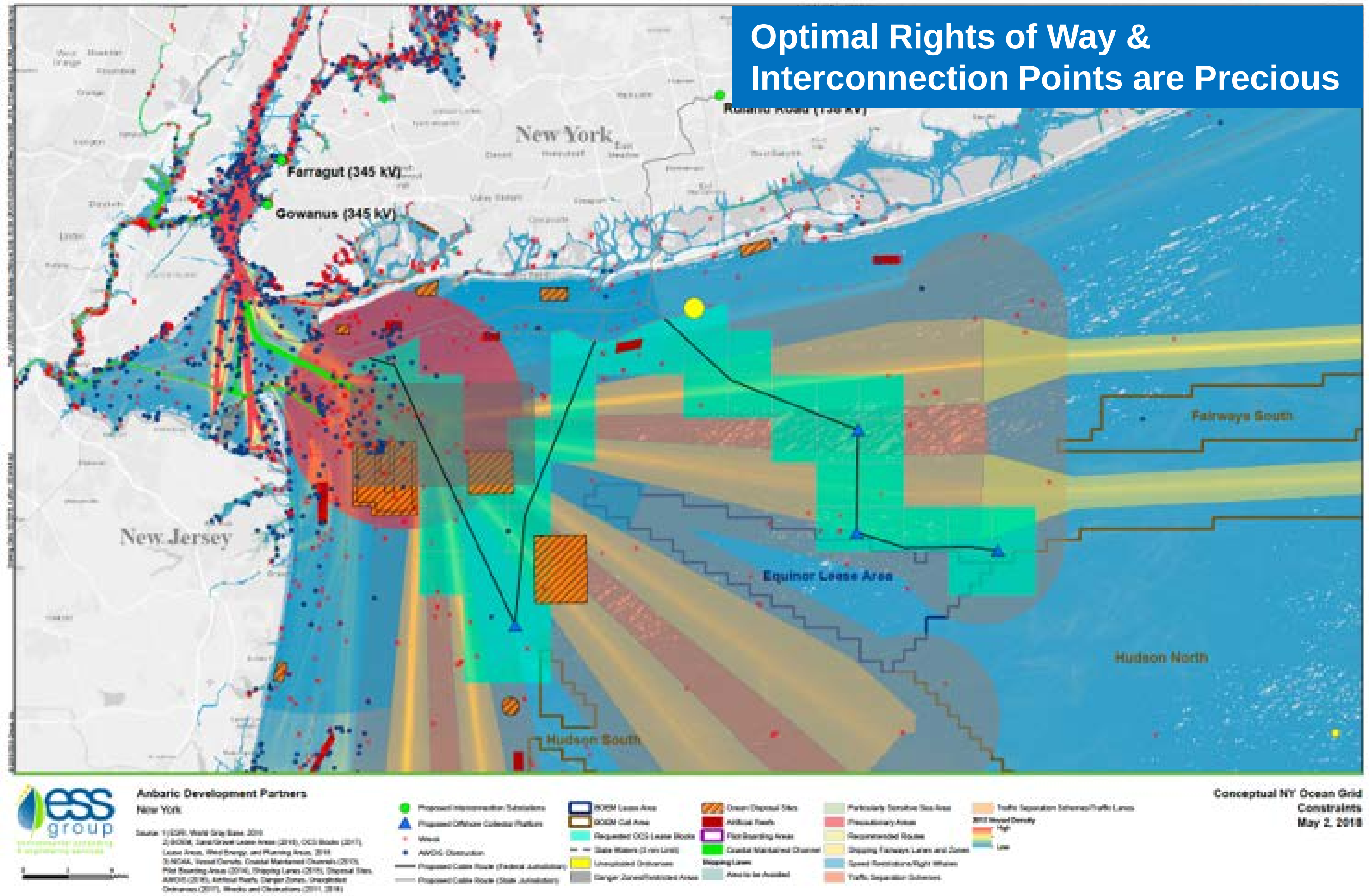


An outcome in which each MW wind farm has its own dedicated cable to shore would:

- **Lead to an unnecessary proliferation of transmission cables** (with cost implications).
- **Create greater impacts** on coastline waters, wetland areas, fisheries, and affected neighborhoods.
- **Incentivize wind developers to select the easiest-to-reach interconnection points** with the onshore grid, irrespective of the needs of the grid operators in distributing that energy to consumers.
- **Tie up and under-utilize the best interconnection points** and rights-of-way onshore and inefficiently preclude maximum utilizations of these interconnections.

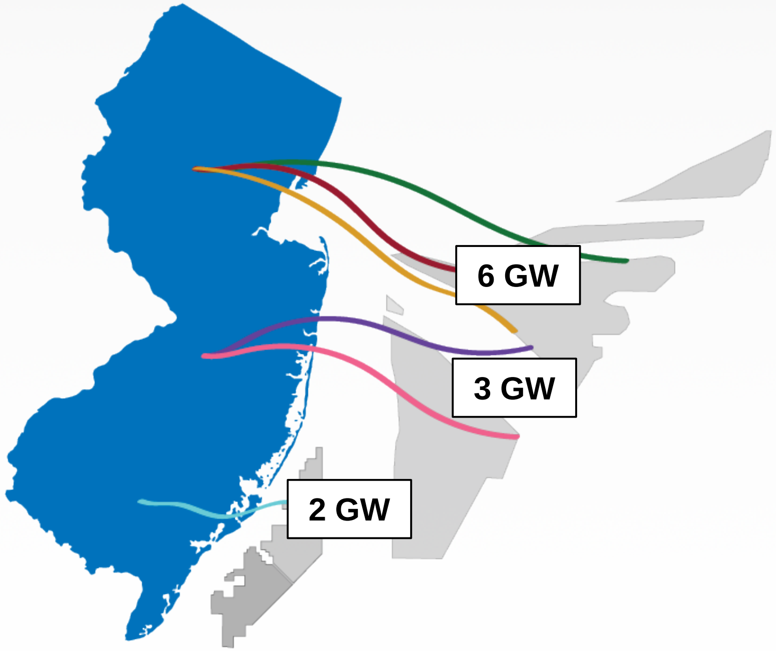
Routing challenges in waters off New York



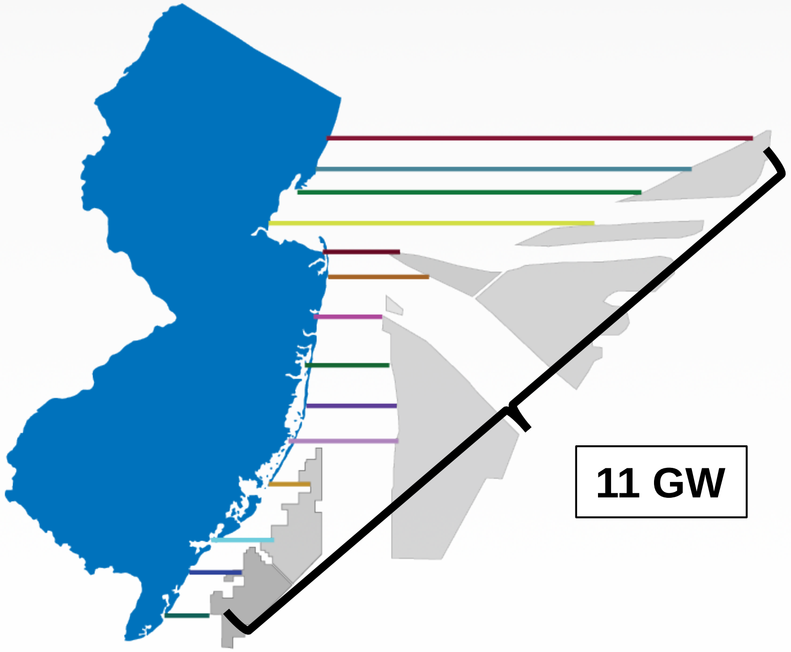


A contrast between planned and unplanned offshore Transmission

Planned



Unplanned



Benefits of a planned grid to deploy offshore wind energy

A planned offshore and onshore grid to accommodate offshore wind, if well designed and implemented, can:

- Maximize our ability to meet offshore wind and clean energy goals.
- Reduce risks associated with one-off project development;
- Create optionality for future expansion;
- Enhance competition that lowers costs to ratepayers;
- Optimize integration with the existing grid by maximizing utility of existing substations, lessening upgrade costs;
- Lessen disruption to fisheries, marine ecosystems and shoreline communities.
- Provide certainty for the offshore industry and local supply chain, ports to grow smoothly over time.
- Integrate in battery storage to address intermittency and minimize curtailments.

States are starting to think about how best to plan for an OSW grid

New York

Governor Cuomo, January 2019: "Transmission: Initiate a first of its kind effort to evaluate and facilitate the development of an offshore transmission grid that can benefit New York ratepayers by driving down offshore wind generation and integration costs."

Massachusetts

The Massachusetts Department of Energy Resources (DOER): In a report this past May, recommends an evaluation of whether to conduct an independent solicitation for offshore wind transmission infrastructure, separate from generation, in 2020. Offshore wind transmission workshop planned for early 2020.

New Jersey

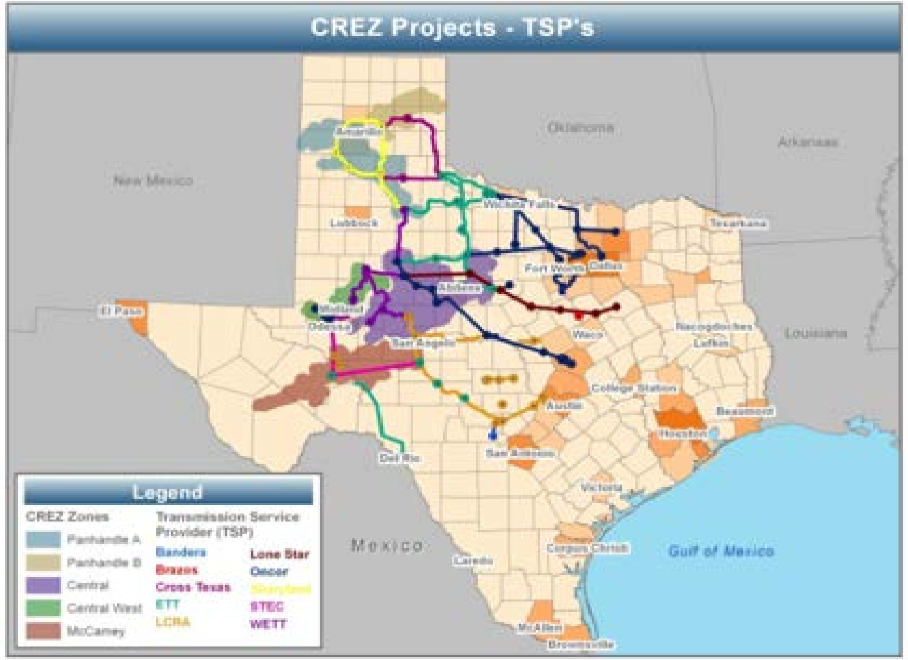
NJ Senate Environment and Public Works Committee: Unanimously reported out a bill on 11/18 to authorize "offshore wind transmission facilities" to participate in offshore wind procurements.

NJ Board of Public Utilities: Convenes a public hearing on 11/12 planned offshore wind transmission. Governor's Draft Energy Master Plan commits to conduct a study on the future of transmission as it prepares for future OSW solicitations.

Tale of two states: What works vs. what doesn't

Texas Model

Planned, open access transmission spurs growth.
In great part because of creating Competitive Renewable Energy Zones (CREZ), Texas has the highest amount of installed wind capacity in the country (nearly 25 GW), yielding 25,000 jobs, $46 billion in capital investment and $307 million each year in landowner payments and state and local taxes.



Maine Model

2020 Target: 3000 MW onshore wind

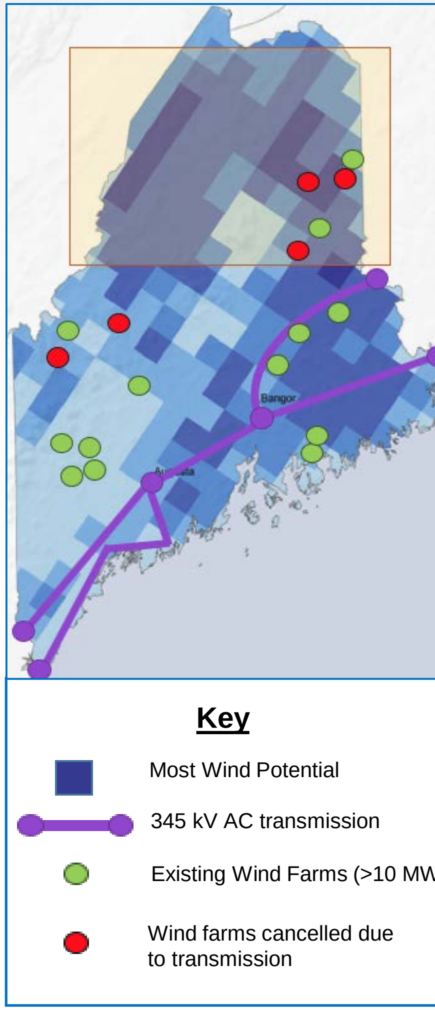
2015 Target: 2000 MW onshore wind

2019 Result: 923 MW onshore wind

At least five major wind farms cancelled due to transmission constraints and interconnection delays.

10-year delay in addressing transmission bottleneck.

Only 22.8 MW have been built since 2016, few projects are in development, onshore wind industry has been bypassed by offshore wind and Canadian hydro.



Planning and building the right offshore network for the onshore grid

Begin at the End: What is needed to reach goals?

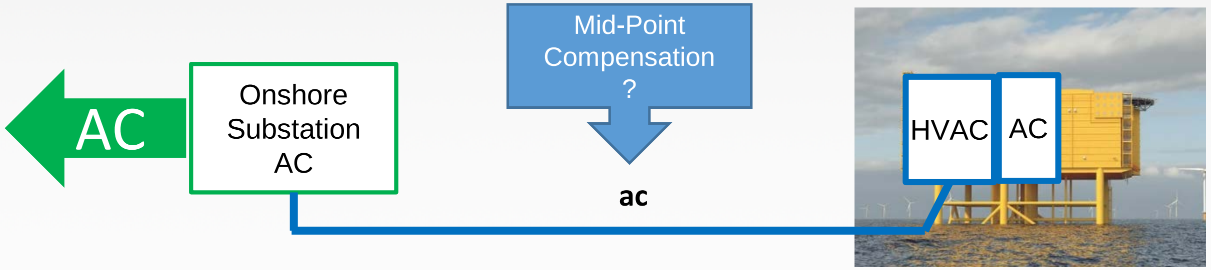
> Onshore upgrades/implementation more difficult than offshore.
> Use the offshore network to support/upgrade the onshore grid.
> Ultimate goals – Generation/Timing/Flexibility/Cost/Competition

To build a suitable grid:

> Identify robust onshore POIs and maximize/build new.
> Upgrade ability to move wind energy to where it's most needed.
> Consider integration of battery storage to minimize curtailments.
> Design to:
  + *Minimize offshore cables/landings.*
  + *Maximize utilization of wind resources.*
  + *Minimize seabed impact by reducing number of cables.*
  + *Enhance redundancy, resiliency and reliability.*

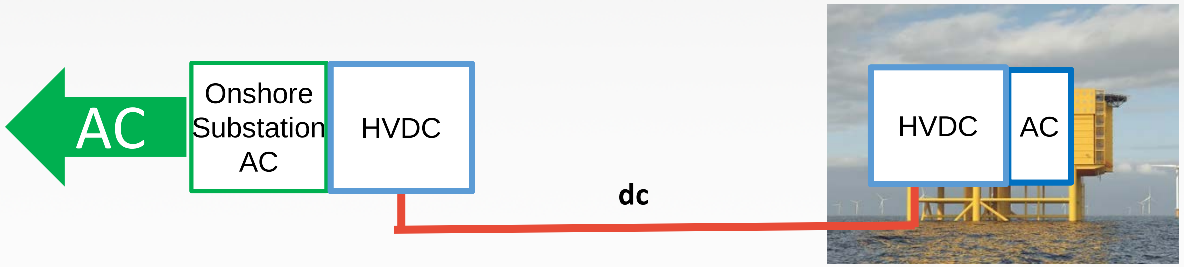
HVAC and HVDC offshore technology gives us options

HVAC (High Voltage Alternating Current)



- Competitive for close shore project
- Higher Losses
- Power quality limitations at POI
- Smaller platform/substation than HVDC
- If close to or beyond distance limit, additional platform needed at midpoint
- More cables, space impacts

HVDC (High Voltage Direct Current)



- Competitive for far shore project
- Lower overall losses
- Controllable operations asset
- Larger platforms/substation
- System stability by inherent HVDC equipment capability
- Fewer cables

Offshore transmission technology innovation is advancing quickly

Dutch-German offshore grid operator TenneT TSO has announced they are developing two 2 GW offshore HVDC grid connections for integrating IJmuiden Ver wind farms into the Dutch power grid.

WTG voltages going up
Cable voltages going up
Innovation:
Fabrication/Modular/Foundations

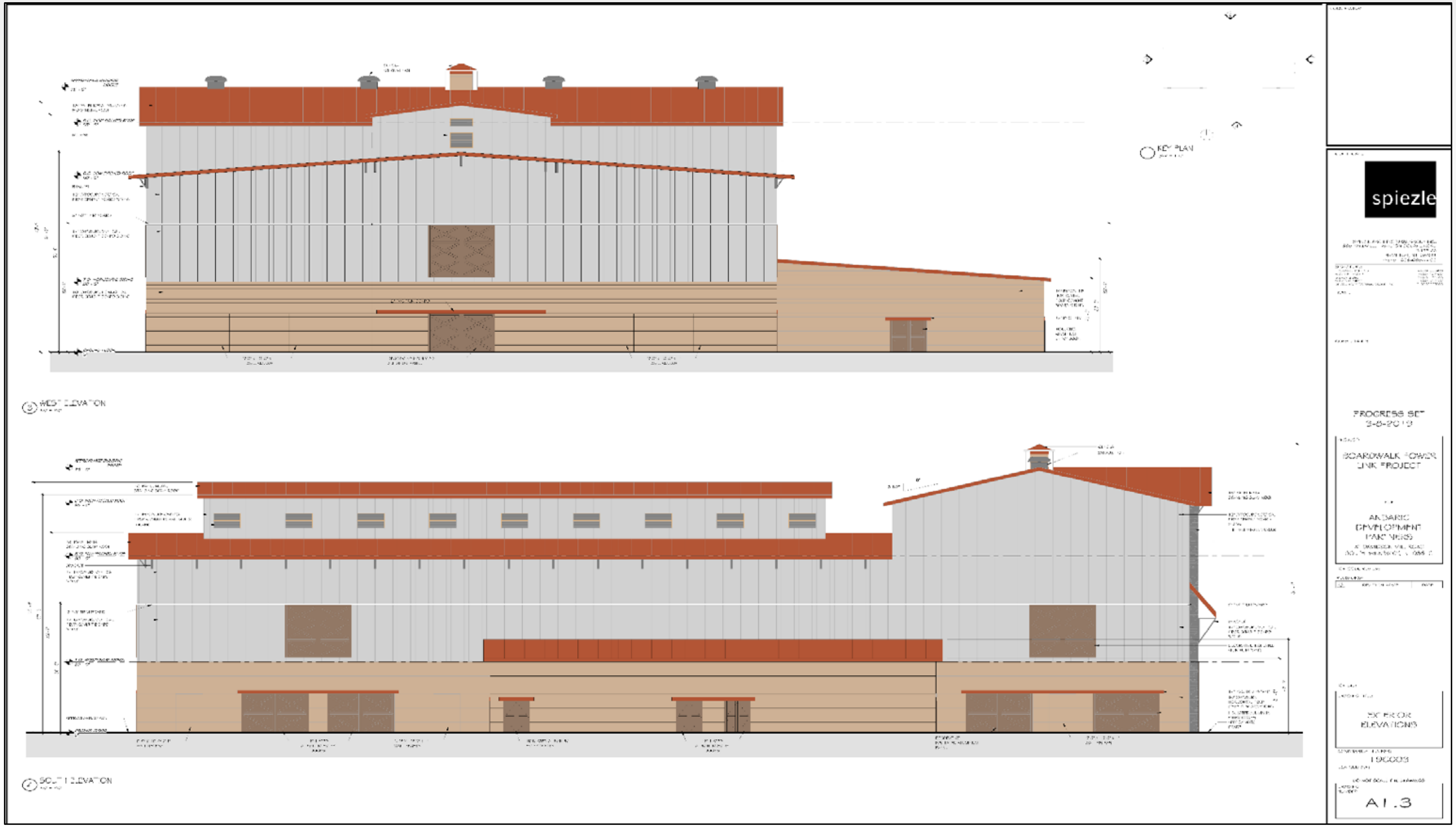
Source: Illustration from Tennet
www.tennet.eu/nl/ons-hoogspanningsnet/net-op-zee-projecten-nl/net-op-zee-ijmuiden-ver-alpha/

Examples of evolving transmission infrastructure architecture

Seattle's new Denny Substation for Amazon

"Temple" Convertor Station from Malaysia

Architect’s drawing of a 1200 MW HVDC converter station



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Integrating battery storage and offshore wind energy

Adding large battery storage capacity to an offshore wind project provides a flexible tool to grid operators to meet electricity demand.

(Photo: Southern California Edison selected the 100 MW Advancion energy storage platform, built by Fluence near Long Beach, CA, to provide on-demand capacity for Los Angeles's peak loads.)

Types of offshore transmission infrastructure

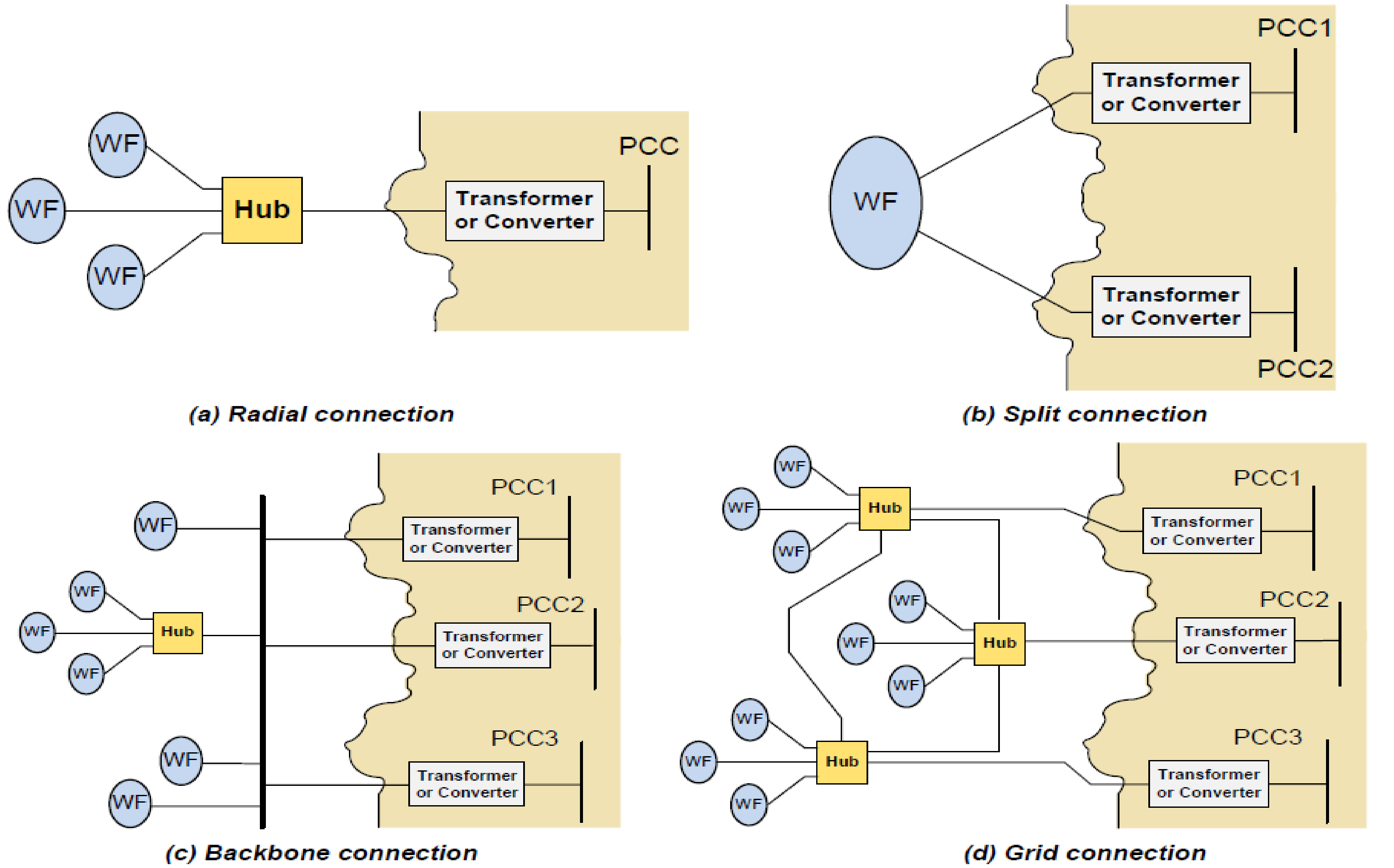


Figure ES-10. Offshore wind farm delivery system options

Fig ES-10: National Offshore Wind Energy Grid Interconnection Study, ABB, Inc.

Type depends on need.

Options provide phased paths from initial grid to final grid design.

One take on the primary design options

Radial Generator Leads

- ✓ Follows the existing interconnection process – each OSW hub is connected to a specified point of interconnection (POI) for a specified MW capacity

Backbone Multi-Terminal HVDC

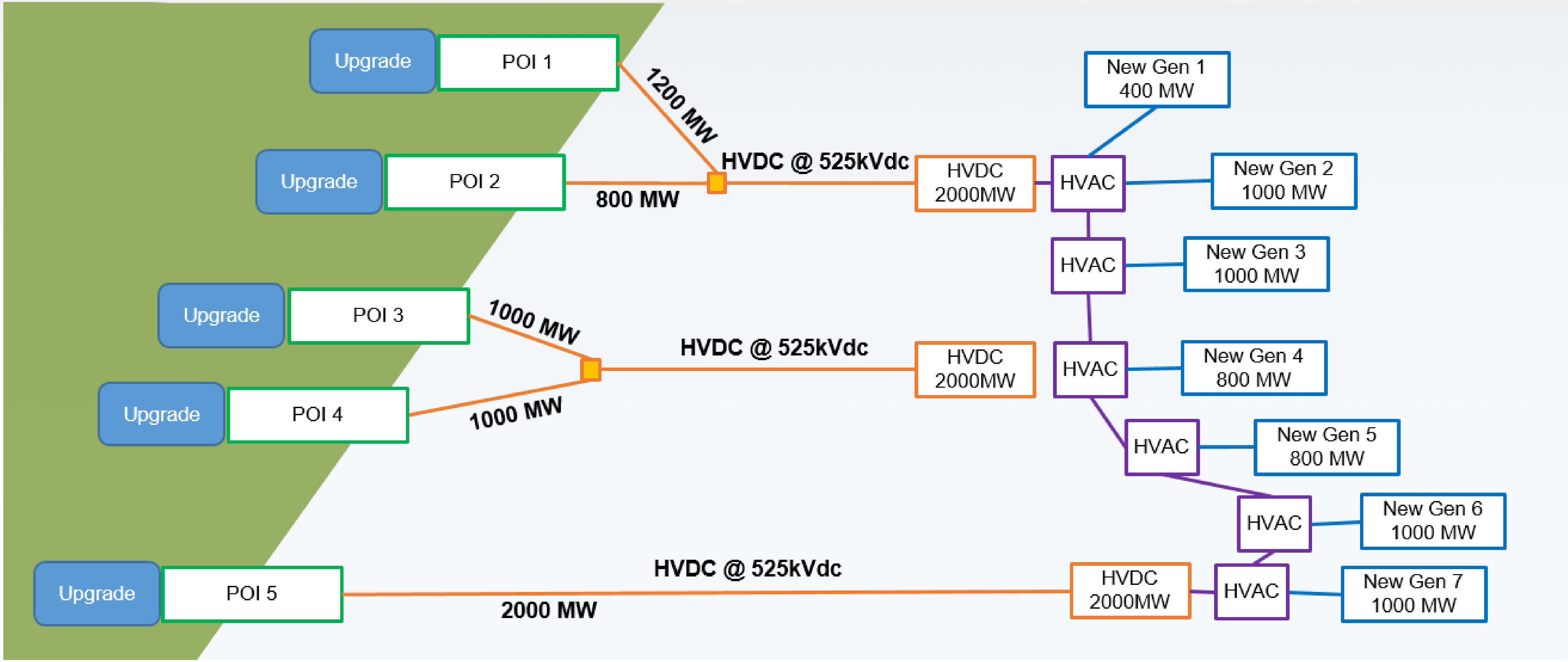
- ✓ A set of OSW hubs are connected together via submarine cables in an MTDC configuration – this is the backbone system
- ✓ A set of terrestrial POIs connect to the backbone system
- ✓ Each OSW hub and POI is equipped with a converter station to deliver or receive the OSW power
- ✓ Flexible and expandable system

Dedicated Receiving Substations

- ✓ A set of land based substations are designated as receiving points for incoming OSW power
- ✓ OSW hubs may be connected to the dedicated substation radially, or in an MTDC arrangement
- ✓ At the receiving substations, power is converted to AC and linked to the existing AC grid
- ✓ Fewer routes to shore

A hub is where OSW power is collected and stepped up to HVAC or converted to HVDC
Source: Pterra Consulting

Offshore Grid: Overall concept 6,000MW



Questions/Comments?

Kevin Knobloch, President
New York OceanGrid LLC
Anbaric Development Partners

kknobloch@anbaric.com
617-480-5003